CLAIMS

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is as follows:

1. A method for producing a halftoned image, comprising:

calculating errors corresponding to a plurality of different viewing conditions of a halftoned image; and

minimizing a function of the errors, such that said halftoned image appears as a different image under different viewing conditions.

2. The method of claim 1, where said function of the errors comprises a sum of absolute values of the errors.

3. The method of claim 1, where said function of the errors comprises a sum of the magnitude of the errors.

4. The method of claim 1, wherein said minimizing comprises:

at each image pixel, selecting an output pixel color which minimizes the function of the errors for said pixel.

5. The method of claim 1, wherein, for each viewing condition, the

corresponding image is different.

6. The method of claim 1, further comprising:

creating the halftoned image such that said image appears as image N_j under viewing condition j for each j, a plurality of images N_1, N_2, ..., being embedded into the halftoned image.

7. The method of claim 1, further comprising comparing a value of said function of errors to an upper bound, and if said value is greater than said upper bound, then capping said function value to said upper bound.

8. The method of claim 1, further comprising comparing a value of said function of errors to a lower bound, and if said value is lower than said lower bound, then setting said value to said lower bound.

9. The method of claim 1, wherein said viewing conditions comprise at least one of a viewing angle, a temperature of said image, a humidity of said image, and a lighting condition of said image.

10. The method of claim 1, wherein, for predetermined color formats having a predetermined large number of colors, said image is divided into predetermined channels and said minimizing is applied to each channel

independently, and

wherein all images are expressed in a same color space.

11. The method of claim 6, wherein said images are expressed in different color spaces.

12. The method of claim 10, where said channels comprise red, green and blue color channels.

13. The method of claim 10, where said channels comprise cyan, magenta and yellow color channels.

14. The method of claim 1, wherein a number of displayable colors is minimized to a predetermined size.

15. The method of claim 1, wherein two images are independently halftoned by performing a bilevel error diffusion, such that at each pixel position, the pixels of the two halftoned images form a pixel pair having a plurality of forms, from which an output color is chosen.

16. The method of claim 1, wherein color characteristics of images printed by a printer or displayed on a display are changed as the viewing conditions

change.

17. The method of claim 1, wherein color characteristics are maintained of images generated on said display device as the viewing conditions change.

18. The method of claim 1, wherein each column k and row l of an image is processed such that the process loops through each pixel of the image.

19. The method of claim 1, wherein, for each pixel of the image a processing is made through each viewing condition.

20. The method of claim 19, wherein for each viewing condition, a modified input image M_j is created, by taking a current input pixel of image N_j along with a weighted sum (w_j) of errors (e_j) that have been generated previously, and

wherein with said modified input generated, an index t is selected to determine the output color c_t.

21. The method of claim 20, wherein the error e_j that occurs by selecting a particular output (a_{ij}) is found for each viewing condition j by subtracting a particular output a_{ij} from the modified output M_j and the sum of the errors e_j is calculated by summing the errors under all of the viewing conditions, and

wherein the output color is selected which minimizes the summed errors.

22. The method of claim 1, wherein the output selected is c_t and the errors e_j are propagated out to neighboring pixels.

23. The method of claim 22, wherein, for each viewing condition j, an upper and lower bound is applied to the error to prevent said error from becoming larger than a first predetermined value or from becoming smaller than a second predetermined value.

24. The method of claim 1, wherein given images N_1, N_2, ..., a halftoned image is created which looks like image N_j under viewing condition j for each j,

wherein $N_j(k,l)$ denotes a (k,l)th pixel of image N_j,

wherein a modified input for a viewing condition j is defined as

$$M_j(k,l) = N_j(k,l) + \sum_{u,v} w_j(u,v)e_j(k-u,l-v)$$

where $e_j(k, l)$ is the error corresponding to viewing condition j at the (k, l)th pixel, and an aggregate error at the (k, l)th pixel for choosing c_i as the output pixel color is given by:

$$Err(i,k,l) = \sum_j |M_j(k,l)-a_{ij}|$$

and wherein an output pixel color at the (k,l)-th pixel is defined as:

$$o(k,l) = c_t \text{ where } t = \underset{i}{\operatorname{argmin}} Err(i,k,l)$$

where o(k, l) is a printable color c_t which minimizes the aggregate error Err.

25. The method of claim 24, wherein the error $e_j(k,l)$ is defined as $M_j(k,l) - a_{mj}$ if and only if $o(k,l) = c_m$.

26. The method of claim 24, wherein w_j is the error weights matrix corresponding to an error diffusion algorithm.

27. A method for producing a halftoned image, comprising:

calculating errors corresponding to a plurality of different viewing conditions of a halftone image; and

minimizing a function of the errors, such that said halftoned image appears as a same image under the different viewing conditions.

28. The method of claim 27, wherein said function comprises a sum of absolute values of the errors.

29. The method of claim 27, wherein said minimizing comprises:

at each image pixel, selecting an output pixel color which minimizes the function of the errors for said pixel.

30. The method of claim 27, wherein, for each viewing condition, the corresponding image is the same.

31. The method of claim 27, further comprising:

creating the halftoned image such that said image appears as image N_j under viewing condition j for each j, a plurality of images N_1, N_2, ..., being embedded into the halftoned image.

32. The method of claim 27, further comprising comparing a value of said function of errors to an upper bound, and if said value is greater than said upper bound, then capping said function value to said upper bound.

33. The method of claim 27, further comprising comparing a value of said function of errors to a lower bound, and if said value is lower than said lower bound, then setting said function value to said lower bound.

34. The method of claim 27, wherein said viewing conditions comprise at least one of a viewing angle, a temperature of said image, and a lighting condition of said image.

35. The method of claim 27, wherein, for predetermined color formats having

a predetermined large number of color, said image is divided into predetermined channels and said minimizing is applied to each channel independently, and

wherein all images are expressed in a same color space.

36. The method of claim 31, wherein said images are expressed in different color spaces.

37. The method of claim 35, where said channels comprise red, green and blue color channels.

38. The method of claim 35, where said channels comprise cyan, magenta and yellow color channels.

39. The method of claim 27, wherein a number of displayable colors is minimized to a predetermined size.

40. The method of claim 27, wherein two images are independently halftoned by a performing a bi-level error diffusion, such that at each pixel position, the pixels of the two halftoned images form a pixel pair having a plurality of forms, from which an output color is chosen.

41. A system for producing a halftoned image, comprising:

a calculator for calculating errors corresponding to a plurality of different viewing conditions of a halftone image; and

an error minimizer for minimizing a function of the errors, such that said halftoned image appears as a different image under different viewing conditions.

42. A system for producing a halftoned image, comprising:

a calculator for calculating errors corresponding to a plurality of different viewing conditions of a halftone image; and

an error minimizer for minimizing a function of the errors, such that said halftoned image appears as a same image under the different viewing conditions.

43. A signal-bearing medium tangibly embodying a program of machine-readable instructions executable by a digital processing apparatus to perform a method for producing a halftoned image, said method comprising:

calculating errors corresponding to a plurality of different viewing conditions of a halftone image; and

minimizing a function of the errors, such that said halftoned image appears as a different image under different viewing conditions.

44. A signal-bearing medium tangibly embodying a program of machine-readable instructions executable by a digital processing apparatus to perform a method for producing a halftoned image, said method comprising:

calculating errors corresponding to a plurality of different viewing conditions of a halftone image; and

minimizing a function of the errors, such that said halftoned image appears as a same image under the different viewing conditions.